



Kromhout, H., Slottje, P., Huss, A., Van Nierop, L. E., Bongers, S., Schaap, K., & de Vocht, F. (2017). ICNIRP Statement on diagnostic devices using non-ionizing radiation: Existing regulations and potential health risks. *Health Physics*, 113(2), 149-150.  
<https://doi.org/10.1097/HP.0000000000000686>

Peer reviewed version

Link to published version (if available):  
[10.1097/HP.0000000000000686](https://doi.org/10.1097/HP.0000000000000686)

[Link to publication record in Explore Bristol Research](#)  
PDF-document

This is the author accepted manuscript (AAM). The final published version (version of record) is available online via Wolter Kluwer at [http://journals.lww.com/health-physics/Fulltext/2017/08000/ICNIRP\\_Statement\\_on\\_Diagnostic\\_Devices\\_Using.8.aspx](http://journals.lww.com/health-physics/Fulltext/2017/08000/ICNIRP_Statement_on_Diagnostic_Devices_Using.8.aspx). Please refer to any applicable terms of use of the publisher.

## University of Bristol - Explore Bristol Research

### General rights

This document is made available in accordance with publisher policies. Please cite only the published version using the reference above. Full terms of use are available:  
<http://www.bristol.ac.uk/red/research-policy/pure/user-guides/ebr-terms/>



Kromhout, H., Slottje, P., Huss, A., van Nierop, L., Bongers, S., Schaap, K., & De Vocht, F. (2017). Letter to the Editor re "ICNIRP STATEMENT ON DIAGNOSTIC DEVICES USING NON-IONIZING RADIATION: EXISTING REGULATIONS AND POTENTIAL HEALTH RISKS". Health Physics.

Peer reviewed version

[Link to publication record in Explore Bristol Research](#)  
PDF-document

## **University of Bristol - Explore Bristol Research**

### **General rights**

This document is made available in accordance with publisher policies. Please cite only the published version using the reference above. Full terms of use are available:  
<http://www.bristol.ac.uk/pure/about/ebr-terms.html>

# Health Physics Journal

## Letter to the Editor re "ICNIRP STATEMENT ON DIAGNOSTIC DEVICES USING NON-IONIZING RADIATION: EXISTING REGULATIONS AND POTENTIAL HEALTH RISKS"

--Manuscript Draft--

Manuscript Number:	
Full Title:	Letter to the Editor re "ICNIRP STATEMENT ON DIAGNOSTIC DEVICES USING NON-IONIZING RADIATION: EXISTING REGULATIONS AND POTENTIAL HEALTH RISKS"
Article Type:	Letter to the Editor
Section/Category:	Health Physics Journal
Keywords:	MRI; static magnetic fields; ICNIRP; systematic review; symptoms
Corresponding Author:	Hans Kromhout Utrecht University Utrecht, NETHERLANDS
Corresponding Author Secondary Information:	
Corresponding Author's Institution:	Utrecht University
Corresponding Author's Secondary Institution:	
First Author:	Hans Kromhout
First Author Secondary Information:	
Order of Authors:	Hans Kromhout Pauline Slottje Anke Huss Lotte van Nierop Suzan Bongers Kristel Schaap Frank de Vocht
Order of Authors Secondary Information:	

Hans Kromhout, Pauline Slottje, Anke Huss, Lotte van Nierop, Suzan Bongers, Kristel Schaap, Frank de Vocht

To the Editor-in-Chief,

We read with great interest the 'ICNIRP Statement on Diagnostic Devices Using Non-ionizing Radiation: Existing Regulations and Potential Health Risks', published in the March 2017 issue of Health Physics (ICNIRP, 2017). Our interest concerned in particular the evaluation of potential health risks related to exposure to (stray) static magnetic fields resulting from diagnostic MRI procedures in patients. Given that ICNIRP is recognised as an official collaborating NGO by international organisations such as the World Health Organization and the International Labour Organization and that ICNIRP is consulted by the European Commission, its statements are considered as authoritative. We therefore expected that their hazard evaluation would be based on a systematic and up-to-date review summarising the complete available evidence in a balanced and unbiased way. To our surprise, however, the authors of the ICNIRP Statement pointed out their assessment of possible adverse effects from diagnostic use of MRI was based on 'a non-systematic review of the literature for relevant epidemiological studies and clinical reports and by hand-searching references of key reports'. Furthermore, it is unclear what period is covered in the ICNIRP Statement. The WHO, HPA and ICNIRP review reports that were cited covered only the years up to 2009, while the reference list included few more recent papers. The potential for biases of such a non-systematic reviewing of the scientific literature are well-recognized and to mitigate this, protocols for transparent reporting of systematic reviews and meta-analysis (PRISMA) (Moher et al., 2009), as well as for the assessment of remaining biases (ROBIS) (Whiting et al., 2016), have been developed and the Cochrane Collaboration (<http://www.cochranelibrary.com/>) has been established.

Although a full assessment of potential biases and missed research is beyond the scope of this Letter, it became obvious to us, that the readers are unfortunately withheld relevant available literature (published in the past few years). The results of several experimental studies have not been included. For example several (double-blind) randomized controlled trials provided convincing evidence of effects on neurocognitive performance and postural body sway as a result of exposure to MRI-related stray fields. (de Vocht et al. 2003; de Vocht et al. 2007a; De vocht et al. 2007b; van Nierop et al. 2012; van Nierop et al. 2013; van Nierop et al. 2015). Also, a study by Heinrich et al. (2014), which reported dizziness among volunteers exposed to homogeneous SMF inside bores of MRI-scanners with different magnet strengths, was not discussed. This work has been supported by experimental studies that examined the effect of a strong SMF on vestibular responses in human subjects and found an effect on involuntary eye movements and vertigo, both of which were associated with the direction of the SMF in relation to the vestibular organ (Roberts et al., 2011; Mian et al., 2013; Ward et al., 2014). ICNIRP did report that "A meta-analysis of 5 studies published during 1992–2007 found the only neuropsychological effect relating to static magnetic field exposure to be visual impairment.", but no reference was presented. It most likely refers to a paper by Heinrich et al. published in 2011. However, this paper suffered from methodological flaws (de Vocht et al. 2012).

Another example of available research not included in this ICNIRP statement relates to realistic occupational scenarios of workers in MRI production and MRI technicians in health care and scientific

research. This research has been indicative of exposure-dependent associations between exposure to (stray) SMFs and transient symptoms (de Vocht et al., 2006; Wilen and de Vocht 2011, de Vocht et al., 2015), which was also confirmed in patients (Heilmaier et al., 2011). An observational study among MRI technicians reported an association between vertigo and measured exposure to MRI-related static magnetic fields (SMF) in an exposure-dependent manner (Schaap et al. (2016)). Finally, with regard to potential health effects from long-term occupational exposure to SMF from MRI scanners, ICNIRP highlights that “well-defined MRI worker cohorts would be useful”, yet the ICNIRP statement (2017) does not present the available results from a cohort study among workers from an MRI manufacturing facility (Bongers et al. 2016). Analyses in this cohort study are ongoing but as yet an association was found between MRI-related occupational SMF exposure and an increased risk of accidents leading to injury, and for commute-related (near) accidents during the commute from home to work. This finding needs confirmation and merits follow-up.

Given the examples above, it is clear to us that ICNIRP by performing a non-systematic review has unfortunately provided the readership of *Health Physics* with an incomplete, not up-to-date, and biased overview of the scientific literature on health risks and symptoms associated with exposure to MRI-related (stray) fields. Nevertheless, in line with the authors’ conclusions we postulate there is at present no evidence that the patients’ benefit/harm trade-off of MRI would be anything other than positive, and we agree that further research into health effects of (long-term) SMF exposure is warranted given recent findings for workers exposed to these extreme static magnetic fields. It would have been better if the readership had been provided with the results of a systematic review. This would have helped pointing out gaps in knowledge and guidance as to what lines and topics of further research would be most helpful/informative.

## References

- Bongers S, Slottje P, Portengen L, Kromhout H. Exposure to static magnetic fields and risk of accidents among a cohort of workers from a medical imaging device manufacturing facility. *Magn Reson Med*. 2016 May;75(5):2165-74. doi: 10.1002/mrm.25768.
- Heilmaier C, Theysohn JM, Maderwald S, Kraff O, Ladd ME, Ladd SC. A large-scale study on subjective perception of discomfort during 7 and 1.5 T MRI examinations. *Bioelectromagnetics*. 2011 Dec;32(8):610-9. doi: 10.1002/bem.20680.
- Heinrich A, Szostek A, Nees F, Meyer P, Semmler W, Flor H. Effects of static magnetic fields on cognition, vital signs, and sensory perception: a meta-analysis. *J Magn Reson Imaging*. 2011 Oct;34(4):758-63. doi: 10.1002/jmri.22720. Review.
- Heinrich A, Szostek A, Meyer P, Reinhard I, Gilles M, Paslakis G, Rauschenberg J, Gröbner J, Semmler W, Deuschle M, Meyer-Lindenberg A, Flor H, Nees F. Women are more strongly affected by dizziness in static magnetic fields of magnetic resonance imaging scanners. *Neuroreport*. 2014 Oct 1;25(14):1081-4. doi: 10.1097/WNR.0000000000000225.
- International Commission on Non-Ionizing Radiation Protection (ICNIRP). ICNIRP Statement on Diagnostic Devices Using Non-ionizing Radiation: Existing Regulations and Potential Health Risks. *Health Phys*. 2017 Mar;112(3):305-321. doi: 10.1097/HP.0000000000000654.
- Mian OS, Li Y, Antunes A, Glover PM, Day BL. On the vertigo due to static magnetic fields. *PLoS One*. 2013;8(10):e78748.
- Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group. *Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement*. [PLoS Med 2009; 6\(7\): e1000097. doi:10.1371/journal.pmed1000097](https://doi.org/10.1371/journal.pmed1000097)

- 1 - van Nierop LE, Slottje P, van Zandvoort MJ, de Vocht F, Kromhout H. Effects of magnetic stray  
2 fields from a 7 tesla MRI scanner on neurocognition: a double-blind randomised crossover  
3 study. *Occup Environ Med*. 2012 Oct;69(10):759-66. doi: 10.1136/oemed-2011-100468.
- 4 - van Nierop LE, Slottje P, Kingma H, Kromhout H. MRI-related static magnetic stray fields and  
5 postural body sway: a double-blind randomized crossover study. *Magn Reson Med*. 2013  
6 Jul;70(1):232-40. doi: 10.1002/mrm.24454.
- 7 - van Nierop LE, Slottje P, van Zandvoort M, Kromhout H. Simultaneous exposure to MRI-  
8 related static and low-frequency movement-induced time-varying magnetic fields affects  
9 neurocognitive performance: A double-blind randomized crossover study. *Magn Reson Med*.  
10 2015 Sep;74(3):840-9. doi: 10.1002/mrm.25443.
- 11 - Roberts DC, Marcelli V, Gillen JS, Carey JP, Della Santina CC, Zee DS. MRI magnetic field  
12 stimulates rotational sensors of the brain. *Curr Biol*. 2011;21(19):1635-1640.
- 13 - Schaap K, Portengen L, Kromhout H. Exposure to MRI-related magnetic fields and vertigo in  
14 MRI workers. *Occup Environ Med*. 2016 Mar;73(3):161-6. doi: 10.1136/oemed-2015-103019.
- 15 - de Vocht F, van-Wendel-de-Jooode B, Engels H, Kromhout H. Neurobehavioral effects among  
16 subjects exposed to high static and gradient magnetic fields from a 1.5 Tesla magnetic  
17 resonance imaging system--a case-crossover pilot study. *Magn Reson Med*. 2003  
18 Oct;50(4):670-4.
- 19 - de Vocht F, van Drooge H, Engels H, Kromhout H. Exposure, health complaints and cognitive  
20 performance among employees of an MRI scanners manufacturing department. *J Magn  
21 Reson Imaging*. 2006 Feb;23(2):197-204.
- 22 - de Vocht F, Stevens T, Glover P, Sunderland A, Gowland P, Kromhout H. Cognitive effects of  
23 head-movements in stray fields generated by a 7 Tesla whole-body MRI magnet.  
24 *Bioelectromagnetics*. 2007 May;28(4):247-55.
- 25 - de Vocht F, Liket L, De Vocht A, Mistry T, Glover P, Gowland P, Kromhout H. Exposure to  
26 alternating electromagnetic fields and effects on the visual and visuomotor systems. *Br J  
27 Radiol*. 2007 Oct;80(958):822-8.
- 28 - de Vocht F, Stevens T, Kromhout H. Comment on: Effects of static magnetic fields on  
29 cognition, vital signs, and sensory perception: a meta-analysis *J Magn Reson Imaging*. 2012  
30 Jan;35(1):235-6; author reply 237. doi: 10.1002/jmri.22860.
- 31 - de Vocht F, Batistatou E, Mölter A, Kromhout H, Schaap K, van Tongeren M, Crozier S,  
32 Gowland P, Keevil S. Transient health symptoms of MRI staff working with 1.5 and 3.0 Tesla  
33 scanners in the UK. *Eur Radiol*. 2015 Sep;25(9):2718-26. doi: 10.1007/s00330-015-3629-z.
- 34 - Ward BK, Roberts DC, Della Santina CC, Carey JP, Zee DS. Magnetic vestibular stimulation in  
35 subjects with unilateral labyrinthine disorders. *Front Neurol*. 2014;5:28. doi:  
36 10.3389/fneur.2014.00028 [doi].
- 37 - Whiting P, Savovic J, Higgs JPT, Caldwell DM, Reeves BC, Shea B, Davies P, Kleijnen J,  
38 Churchill R, and ROBIS group. *J Clin Epidemiol* 2016; 69: 225-234.
- 39 - Wilén J, de Vocht F. Health complaints among nurses working near MRI scanners-a  
40 descriptive pilot study. *Eur J Radiol*. 2011 Nov;80(2):510-3. doi: 10.1016/j.ejrad.2010.09.021.